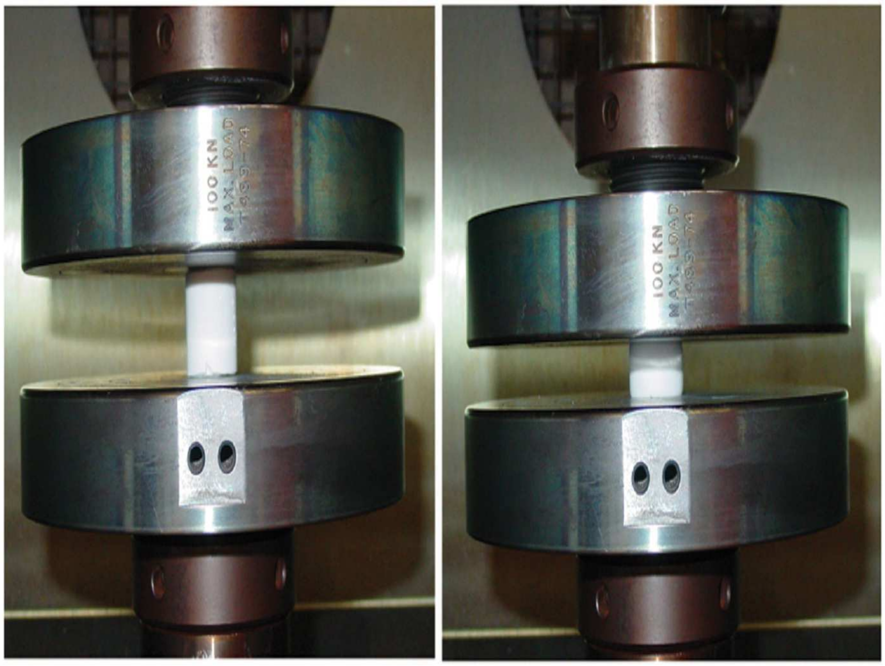


National Aeronautics and
Space Administration

Materials and Coatings

Polymer Cross-Linked Aerogels (X-Aerogels)

Improved environmental durability and elasticity for aerospace and terrestrial applications

NASA Glenn Research Center (GRC) has developed and produced ultra-lightweight polymer cross-linked aerogels (X-Aerogels). These mechanically robust, highly porous, low-density materials are 3 times denser than native aerogels, but more than 100 times stronger.

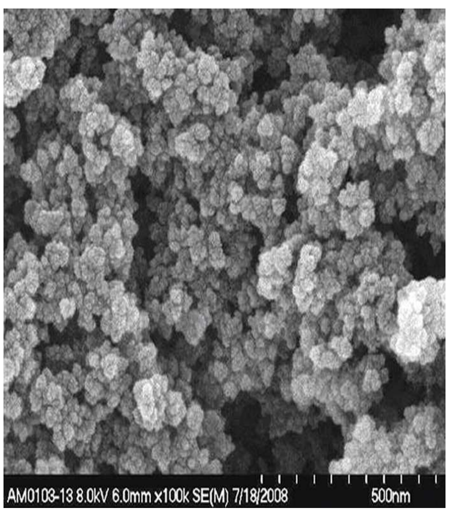
BENEFITS

- Improved strength: More than 100 times stronger than conventional aerogels
- Low thermal conductivity: Enables application for a variety of temperature-challenging environments
- Good optical transparency: Some formulations offer light filtration while maintaining good insulation
- Customizable: Tailored chemistry enables customized polymers for specific mission requirements
- Improved elasticity: Maintain their shape even after repeated compression

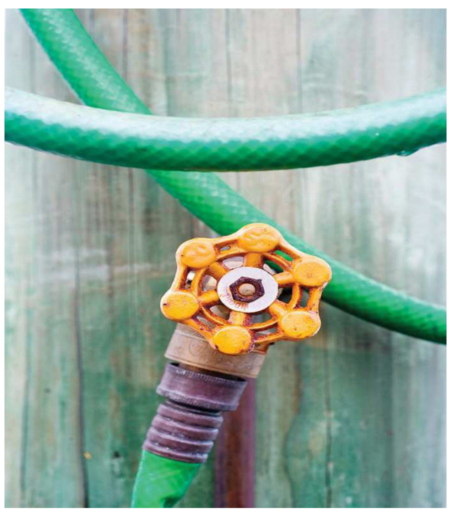
technology solution

THE TECHNOLOGY

Aerogels are ultra-lightweight glass foams with extremely small pores (on the order of 10 to 50 nanometers). These materials are extremely good thermal insulators, with R values ranging from 2 to 10 times higher than polymer foams. Unlike multilayer insulation, aerogels do not require a high vacuum to maintain their low thermal conductivity and can function as good thermal insulators at ambient pressure. In addition, they are good electrical insulators and have low refractive indicesboth approaching values close to air. Aerogels are also excellent vibration damping materials. Traditional aerogels, however, suffer fragility and poor environmental durability. Researchers at NASA GRC have developed an approach to significantly improve the mechanical properties and durability of aerogels without adversely affecting their desirable
properties. This approach involves coating conformally and cross-linking the individual skeletal aerogel nanoparticles with engineering polymers such as isocyanates, epoxies, polyimides, and polystyrene. The mechanism of cross-linking has been carefully investigated and is made possible by two reactions: a reaction between the cross-linker and the surface of the aerogel framework and a reaction propagated by the cross-linker with itself. By tailoring the aerogel surface chemistry, GRCs approach accommodates a variety of different polymer cross-linkers, including isocyanates, acrylates, epoxies, polyimides, and polystyreneenabling customization for specific mission requirements. For example, polystyrene cross-linked aerogels are extremely hydrophobic, while polyimide versions can be used at higher temperatures. Recent work has
led to the development of strong aerogels with better elastic properties, maintaining their shape even after repeated compression cycling. By tailoring the internal structure of the silica gels in combination with a polymer conformal coating, the aerogels may be dried at the ambient condition without supercritical fluid extraction.



The mesoporous structure is maintained after cross-linking



Cross-Linked Aerogels can be used for hose insulation

APPLICATIONS

The technology has several potential applications:

- Thermal insulation for cryogenic containers
- Acoustic and vibration damping materials
- Ballistic impact absorbing materials
- Hose insulation
- Thermal pane skylights
- Catalytic supports
- Dielectrics for fast electronics
- Filtration membranes
- Membranes for fuel cells and batteries
- Optical sensors
- Aerospace components
- Structural components in layered or sandwich-type composites

PUBLICATIONS

Patent No: 7,732,496; 8,227,363; 8,067,478; 8,314,201; 8,258,251

Patent Pending

More Information

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LEW-17685-1, LEW-17685-2, LEW-18042-1, LEW-18042-2, LEW-18265-1, LEW-18265-2